THE COMPLETE ISRM SUGGESTED METHODS FOR ROCK CHARACTERIZATION, TESTING AND MONITORING: 1974-2006

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Suggested Method for Petrographic Description of Rocks

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1. SCOPE

The micro-petrographic description of rocks for engineering purposes includes the determination of all parameters which cannot be obtained from a macroscopic examination of a rock sample, such as mineral content, grain size and texture, and which have a bearing on the mechanical behaviour of the rock or rock mass. A common form of microscopic examination employed for transparent materials involves the use of thin sections and refracted light. Opaque materials can be sawed and polished and then examined using reflected light techniques.

To ensure its correct classification, the first step should be to ascertain the mineral composition and texture of the rock. Further investigations should include a fabric and mineral analysis in the case of strongly anisotropic rocks, the determination of the degree of alteration or weathering, grain size, microfracturing and porosity.

2. APPARATUS

2.1. Equipment for the preparation of thin sections from rock samples typically comprises: (a) A small diamond saw with a saw blade 150–250 mm in diameter; (b) A cast iron plate about 250 × 250 × 20 mm in size for rough grinding, and two glass plates of the same dimensions for fine grinding and finishing or a suitable machine for thin section preparation; (c) Silicon carbide grinding powders of grain numbers 180 or 220 (cast iron plate), 600 (fine grinding) and 1000 (finishing); (d) Glass slides approximately 25 × 45 mm, thickness ±1–2 mm; (e) A suitable cement, e.g. Canada balsam, Lakeside 70 cement or epoxy resin for mounting the rock specimens; (f) Stains for distinguishing minerals by impregnating the rock section.

The thin section may be covered by a microscope cover glass or a suitable lacquer (Merck, Germany) if no further surface treatment is required.

2.2. The equipment for examining the thin section normally consists of a petrographic microscope, as this is best suited to the examination of thin sections. Stereoscopic binocular microscopes have been employed in determining grain size, shape and surface characteristics of individual particles, but this method has many disadvantages when compared with methods in which the petrographic microscope is used. An ore microscope or a metallographic microscope is often useful to identify opaque minerals.

2.3. Equipment to determine the quantitative mineral composition, by volume, of a rock (modal analysis) typically comprises [1]: (a) A planimeter to determine the composition from low-magnification photomicrographs or projected enlargements on a screen; or (b) an integrating stage to quantify the composition by linear measurements on traverses across the thin section; or (c) a mechanical counting stage (point counter) or a suitable eyepiece attachment to determine the composition from the points of a grid placed over the thin section.

2.4. The equipment for measuring the grain size normally consists of a calibrated micrometer eyepiece or a graticule showing typical grain sizes and grain forms.

2.5. Equipment to determine the anisotropy, fabric or texture of a rock. (a) A qualitative assessment of the degree of anisotropy in a thin section can often be made using a $\lambda/2$ (gypsum) interference plate as an attachment to the petrographic microscope. (b) For statistical and quantitative evaluation of the anisotropy, a universal stage and an equal area net (Schmidt net) are essential attachments to the petrographic microscope.

2.6. Special equipment: (a) To determine the composition of very fine-grained rocks such as shales, mudstones, clays, etc., the application of X-ray diffraction techniques, infra-red absorption spectrography or differential thermal analysis is necessary. (b) For the observation of surface features on fracture planes and mineral grains the use of a scanning electron microscope can be of advantage. (c) Equipment for applying resins or pigments to the rock, prior to the preparation of sections.

3. PROCEDURE

3.1. *Preparation*

In order to obtain a representative sample of the rock, more than one specimen should be selected during field work. Wherever possible, oriented specimens should be collected and the original strike and dip of one face of the specimen should be recorded.

The preparation of thin sections has been described in detail by Allman and Lawrence [2].

3.2. *Examination of thin sections*

The determination of the minerals present in a thin section can be carried out only by a trained petrographer, while the modal analysis can be done by any person under the supervision of the petrographer.

Determination of minerals present. Well-established methods and techniques exist [3] for the determination of the minerals present in a thin section, so as to enable the rock to be classified as igneous, metamorphic or sedimentary.

For the purpose of practical rock mechanics, certain simplifications can be made but whenever possible the internationally recognised names of rocks should be used.

For the modal analysis of the rock specimens any one of the methods mentioned previously can be used, depending on the facilities available.

Determination of microfractures and secondary alterations. During the analysis of a specimen, considerable care should be taken to examine it for mechanical flaws, microfractures and layers of apparently weaker material which might have a bearing on the engineering behaviour or strength of the rock. This includes an examination of the degree of weathering or other secondary alterations.

Determination of grain size. A rough estimate of the average grain size is normally part of the examination. However, as the mechanical behaviour of some rocks depends to a large extent on the grain size of the constituent minerals, a thorough measurement of the size distribution of these components is within individual beds or laminations advisable.

The determination of the sizes of essentially spherical particles presents no problem. In contrast, accurate measurement of the sizes of tabular, prismatic or irregular particles may be difficult. For such particles, size may be expressed in terms of volume, mass, maximum, intermediate or minimum intercepts, area or "average" or "nominal" diameters. The "nominal" diameter is obtained by computing the diameter of a sphere having the same volume and density as the particle [2].

Fabric analysis. As the quantitative fabric analysis requires the use of a universal stage by a specially trained operator, the normal analysis should be confined to simple observations which might have an influence on the mechanical behaviour of a rock. This includes comments on the orientation and shape of grains, grain contacts and the matrix or cement. For normal rock mechanics purposes the igneous rocks can be regarded as isotropic apart from macroscopic features such as jointing, fissuring, flow banding and vesicular structures.

4. REPORTING THE RESULTS

The report of a petrographic examination for engineering purposes should be confined to short statements on the case history (project, origin, etc.), the geological classification of the rock and details relevant to the mechanical properties of the specimen or the rock mass. Wherever possible this should be combined with a report on the mechanical parameters such as point-load index, uniaxial or triaxial compressive strength.

A suggested format for a petrographic report is given in the Appendix.

REFERENCES

1. Wahlstrom E. E. *Petrographic Morphology.* John Wiley, New York (1955).
2. Allman M. & Lawrence D. F. *Geological Laboratory Techniques.* Blandford Press, London (1972).
3. Moorhouse W. W. *The Study of Rocks in Thin Sections.* Harper's Geoscience Series, New York (1959).

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APPENDIX: SUGGESTED FORM OF PETROGRAPHIC REPORT

Project:
Location:
Co-ordinates:
Specimen Nº: Collected by:
Description of sampling point:
Thin section Nº: Date:

MACROSCOPIC DESCRIPTION OF SAMPLE

Degree of weathering:

Structure (incl. bedding):

Discontinuities:

RESULTS OF ROCK PROPERTY TESTS

Point load index: Porosity: ....%
........MPa, wet/dry Density: ....kg/m^3
normal/parallel to foliation Water absorption:
Any other results:

GENERAL REMARKS

GEOLOGICAL DESCRIPTION

Rock name:

Petrographic classification:

Geological formation:

QUALITATIVE DESCRIPTION

Texture:

Fracturing:

Alteration:

Matrix:

PHOTO-MICROGRAPH
OF TYPICAL FEATURES
OF THIN SECTION

MINERAL COMPOSITION (MODAL ANALYSIS)

MAJOR COMPONENTS	VOL.%	MINOR COMPONENTS	VOL.%	ACCESSORIES	VOL.%

SIGNIFICANCE OF RESULTS FOR ROCK ENGINEERING	GRAIN SIZE & DISTRIBUTION MICRONS	%